APPENDIX F
PHYSICAL STREAM CONDITION DATA INCLUDING COLLECTION AND ASSESSMENT METHODS

This appendix addresses existing fish habitat, channel morphology, and riparian vegetation conditions along with a general discussion on human activities and potential linkages between these activities and existing conditions. The focus is on non-point sources of pollution, links with riparian vegetation condition and stream morphology, and the relation of riparian and stream morphology conditions to land use practices in the Prospect Creek Watershed. Summarized data and data assessment methods provide the basis for the following discussion.

Existing Data and Watershed Assessments

In 2004 RDG reviewed existing data related to water quality and fish habitat in the Prospect Creek watershed. The existing information reviewed included fish habitat, channel morphology and upland assessments completed primarily by MFWP (Montana Fish Wildlife and Parks), WWP (Washington Water Power), and USFS (US Forest Service). Some of these data are integrated into the general watershed and stream characterization document (RDG, 2004), and some of this information is also presented below. Temperature data are presented in a separate appendix to this document (**Appendix I**). Metals data are presented in a separate document for the Prospect Creek Metals TMDL (DEQ, 2005).

Table F-1. Summary of Existing Biological, Chemical, and Physical Data Reviewed for Prospect Creek

Stream	Use	Biological	Chemical	Physical
Prospect Creek (18.9 miles from Headwaters to Mouth)	B-1	Fisheries Data (MFWP) Fisheries Data (WWP) Fisheries Data (Avista) Macroinvertebrates (WWP) Macroinvertebrates (DEQ)	Temperature (WWP) Temperature (DEQ)	Physical Data (DEQ) Physical Data (MFWP) Physical Data (USFS) Physical Data (WWP)

Reference: RDG, 2004

Fish Habitat Assessments

WWP (1996) quantified fish habitat conditions on Prospect Creek and other tributaries in the Lower Clark Fork River drainage. Prospect Creek was considered deficient in the evaluated habitat categories relative to comparable tributaries. Unlike other streams in the basin experiencing siltation effects, Prospect Creek was found to have low surface fine sediment accumulations. The following excerpt is from the WWP report:

> *"Fish habitat in Prospect Creek consists of primarily low gradient riffle and run habitat types; a substrate mix dominated by gravel and rubble; low amounts of fine sediment; a largely non-functional and altered riparian zone; a riparian vegetation mix consisting of a relatively even mix of vegetation types; and relatively low amounts of LWD." (WWP, 1996, p 201)*

USFS also conducted a fish habitat analysis for Prospect Creek in regard to bull trout habitat (USDA, 2000). Prospect Creek and several of its tributaries were classified primarily as "Functioning at Unacceptable Risk" or "Functioning at Risk" for most habitat quality indicators (**Table F-2**). Inadequate pool frequency, sediment, road density and sub-population size appeared to be the greatest limiting factors in the watershed based on the analysis. According to this analysis the integrated habitat indicator determination for all 6th Code HUC watersheds in Prospect Creek is Functioning at Unacceptable Risk. For the "sediment" habitat indicator, the analysis did not differentiate between coarse sediment (such as bed load) and fine sediment (such as wash load or suspended sediments).

Table F-2. Habitat Indicators for the Prospect Creek Watershed

6th Code HUC	Subpop Size	Water Temp	Sediment	Physical Barriers	Pool Frequency	Refugia	Road Density	Integrated
Clear Creek	FUR	FAR	FUR	FAR	FUR	FAR	FUR	FUR
Cooper Creek	FUR	FA	FAR	FAR	FUR	FAR	FAR	FUR
Crow Creek	FUR	FAR	FUR	FAR	FUR	FAR	FUR	FUR
Dry Creek	FUR	FA	FAR	FAR	FUR	FAR	FAR	FUR
Lower Prospect	FUR	FUR	FUR	FAR	FUR	FAR	FUR	FUR
Upper Prospect	FUR	FA	FAR	FUR	FUR	FAR	FAR	FUR
Wilkes Creek	FUR	FA	FAR	FUR	FAR	FAR	FAR	FUR
FUR = Functioning at Unacceptable Risk, FAR = Functioning at Risk, FA = Functioning Appropriately								

Reference: USDA, 2000

Pool Frequency

Methods

Pool frequency was evaluated in 2004 via two methods. The first method involved collecting a longitudinal profile for 2 segments of Clear, Crow, Cooper and Dry creeks and for Reaches 5 and 6 on mainstem Prospect Creek. Longitudinal profiles were approximately 20 bankfull widths in length. The number of pools and dimensions of pools were later derived from the longitudinal profiles. The second method involved a field count of the number of pools encountered within segments of mainstem Prospect Creek Reaches 2 through 4. The mid-point of each pool sampling segment corresponded to a cross section from the 2003 surveys. Each sample segment extended the length of 10 bankfull widths upstream and 10 bankfull widths downstream of the cross section location, for a total sample length of 20 times the bankfull width of the cross section. The number of pools and pool dimensions were recorded for each sample segment. For the second method, pools were defined as slack water features deeper than surrounding riffles. The approximate residual (base flow) width, depth and length of each pool were measured. It was also noted whether the pool was associated with rip rap or LWD. Pool frequency was calculated using the number of pools divided by the length of the sample segment **(Table F-3)**.

Results

Table F-3.Pool Frequency in the Prospect Creek Watershed

Water Body	Reach/ Cross Section	Surveyor	Sample Method	Rosgen Stream Type	# of Pools	Sample Length (feet)	Pools/ Mile
Main Stem	2/1	RDG	Field Count	D4	14	4228	17.5
Main Stem	2/2	RDG	Field Count	D4/C4	4	2042	10.3
Main Stem	2/3	RDG	Field Count	C4	4	1750	12.1
Main Stem	3/1	RDG	Field Count	C3	1	1234	4.3
Main Stem	3/2	RDG	Field Count	D4	6	3598	8.8
Main stem	3/3	RDG	Field Count	D4	5	2088	12.6
Main Stem	4/1	RDG	Field Count	D4	2	2360	4.5
Main Stem	4/2	RDG	Field Count	D3	4	1634	12.9
Main Stem	4/3	RDG	Field Count	D4b	4	1662	12.7
Main Stem	5 (FS R3&R4)	LNF	Long Profile	C	9	525	90.5
Main Stem	6 (FS R1)	LNF	Long Profile	B	7	634	58.3
Clear	3	RDG	Long Profile	C4	5	900	29.3
Clear	1	RDG	Long Profile	C4	3	1114	14.2
Clear	8 (FS R2b)	LNF	Long Profile	C	6	410	77.3
Crow	2	RDG	Long Profile	C4	6	900	35.2
Crow	1	RDG	Long Profile	C4	2	587	18.0
Cooper	3	RDG	Long Profile	C4/D4	6	965	32.8
Cooper	1	RDG	Long Profile	C/F	3	863	18.4
Dry	3	RDG	Long Profile	C4	8	900	46.9
Dry	1	RDG	Long Profile	C4	4	900	23.5

There is a notable difference in pool frequency values between mainstem Prospect reaches 5 and 6 and other mainstem Prospect reaches. This difference is attributable to two factors.

The first factor has to do with the size and order of the stream in reaches 5 and 6 which are located above Cooper Creek, Crow Creek and other major tributaries to Prospect Creek. Greater pool frequency can be expected in smaller, lower order streams compared to less frequent pools in larger, higher order main stem channels.

The second factor is channel type. Reaches 5 and 6 include C and B channel types whereas the dominant channel type of the downstream reaches is D. Greater pool frequency can be expected in reaches dominated by B and C channel type compared to lower pool frequency in D reaches characterized by aggradation.

LWD Frequency

Methods: TMDL Data

In July 2004, mainstem Prospect Creek and portions of Clear, Dry, Crow and Cooper creeks were inventoried for large woody debris distribution. A similar sampling scheme as used in the bank erosion inventory was also used for LWD sampling.

LWD was inventoried at a subsample of segments representing approximately 25% of the total stream length. For example, on the main stem, four-hundred foot bank lengths were sampled at 1200-foot intervals. (Sample 400', walk 1200' to start next 400' sample segment). Tributary main stems and portions of their tributaries (Dry, Clear, Crow and Cooper Creeks) were also inventoried using a similar sampling method.

LWD was defined as pieces greater than 5 feet long and greater than 4 inches in diameter. For each subsample segment, all LWD pieces within the active bankfull channel, or on or near the stream bank which could be contributed to the active channel in a bankfull or greater event, were tallied by size class. LWD criteria, including size classes are described in **Tables F-4 and F-5**.

Table F-4. Size Classes of Single Pieces of LWD

	Length Range (feet)	Diameter Range (feet)
Very Small	5 - 16	0.3 – 1.0
Small	16-50	1.0-2.5
Medium	>50	1.0-2.5
Large	16-50	> 2.5
Very Large	> 50	> 2.5

Qualifying pieces of LWD in groups of 2 or more were counted as aggregates. The number of aggregates within each subsample segment was tallied. For each aggregate, the approximate number of individual pieces was recorded along with the height, width, length of the aggregate and the approximate percent of the aggregate mass consisting of voids (for estimating total volume of wood). (**Table F-5**).

Table F-5. Large Woody Debris Count Criteria

LWD Category	Criteria	
LWD Singles	> 5 feet long AND > 4 inches in diameter	Number of qualifying pieces by size class
LWD Aggregates	2 or more pieces entangled > 5 feet long AND > 4 inches in diameter	Number of pieces in aggregate, aggregate dimensions (height, width, length) and percent void space

Location and function of the LWD were also noted. Location descriptions included “in-channel” and “recruitable”. In-channel pieces were located within the channel at or below the bankfull elevation. Recruitable pieces were defined as those pieces at or near the stream bank which could be contributed to the active channel in a bankfull or greater event. Noted functions of LWD included bank protection, bank erosion, pool forming, channel forming, and bar storage.

The numbers of sampled single LWD pieces and LWD aggregates per channel length were calculated for each reach. It was assumed that the 25% sub sample provided a representative sample of LWD throughout each reach. Results are presented in **Table F-6**.

Results: TMDL Data

Table F-6. LWD Frequency in the Prospect Creek Watershed (2004)*

Water Body	Reach	Stream Type	Sampling Length	# Singles 5-16'	# Singles > 16'	# Aggregates	Total (Aggregates + Singles > 5')	Total Per Mile (Aggregates + Singles > 5')	Total (Aggregates + Singles > 16')	Total Per Mile (Aggregate + Singles > 16')
Main Stem	R1	B3/F3	--	--	--	--	--	--	--	--
Main Stem	R2	D4/C4	6400	70	145	43	258	213	188	155
Main Stem	"Ref" C	Ref C4	--	--	--	--	--	--	--	--
Main Stem	R3	D4/C4	8400	35	120	66	221	139	186	117
Main Stem	R4	D4/3	4800	54	103	54	211	232	157	173
Main Stem	R5, (FS R3)	C	2400	24	32	22	78	172	54	119
Main Stem	R6	B	--	--	--	--	--	--	--	--
Clear Creek	R1	C4	900	6	15	7	28	164	22	129
Clear Creek	R2	B4c/F4b	600	3	4	2	9	79	6	53
Clear Creek	R3	C4	3300	50	5	50	105	168	55	88
Clear Creek	R4	D4	1200	14	12	17	43	189	29	128
Clear Creek	R1	C4/D4	900	18	3	7	28	164	10	59
Clear Creek	R2	C4/D4	600	5	0	5	10	88	5	44
Clear Creek	R3	C4/D4	--	--	--	--	--	--	--	--
Clear Creek	R4	C4/D4	--	--	--	--	--	--	--	--
Clear Creek	R5	F3	--	--	--	--	--	--	--	--
Clear Creek	R6	C3/D4	--	--	--	--	--	--	--	--
Clear Creek	R7	B3/C3	--	--	--	--	--	--	--	--
Clear Creek	R8	C	--	--	--	--	--	--	--	--
Clear Creek	R9	A/B	--	--	--	--	--	--	--	--
Dry Creek	R1	C4	1500	17	22	21	60	211	43	151
Dry Creek	R2	A3	900	20	9	3	32	188	12	70
Dry Creek	R3	C4	2400	17	37	25	79	174	62	136
Dry Creek	R4, WF	D4b/B4	300	5	2	2	9	158	4	70
Dry Creek	R4, EF	D4b/C4	1500	15	8	11	34	120	19	67
Wilkes Creek	R1	B4c	--	--	--	--	--	--	--	--
Wilkes Creek	R2	C4	--	--	--	--	--	--	--	--
Wilkes Creek	R3	B4c	--	--	--	--	--	--	--	--
Wilkes Creek	R2, (FS R1)	C4	--	--	--	--	--	--	--	--
Wilkes Creek	R3, (FS R2)	C4	--	--	--	--	--	--	--	--

Crow Creek	R1	C3/4	1500	14	14	14	42	148	28	99
Crow Creek	R2	C3/4	900	1	9	16	26	153	25	147
Crow Creek	R1, EF	C4b	900	13	30	15	58	340	45	264
Crow Creek	R1, WF	C4b	900	2	9	20	31	182	29	170
Cooper Creek	R1	F3	300	6	6	2	14	246	8	141
Cooper Creek	R2	B3c	600	3	7	4	14	123	11	97
Cooper Creek	R3	C4/D4	1500	11	9	8	28	99	17	60
Cooper Creek	R4	C4/B	1200	3	13	13	29	128	26	114
Cooper Creek	R5	B4/C	600	2	4	3	9	79	7	62
Cooper Creek	R6	C4/B	300	0	0	1	1	18	1	18
Cooper Creek	R7	B4 to C4	600	1	4	3	8	70	7	62
Cooper Creek	R8	A	--	--	--	--	--	--	--	--
*Includes in-channel and recruitable LWD.										

Methods: Other Data

LWD was also inventoried on mainstem of Prospect Creek by WWP in 1996 and by Watershed Consulting in 1999. WWP also inventoried LWD on Crow Creek in 1996. WWP counted LWD singles, aggregates and rootwads with diameter greater than 0.1 meter within the bankfull channel. Differentiation was made between small woody debris (< 3 m in length) and large woody debris (> 3 m in length). Root wads with stems less than 3 m in length were counted as root wads; if root wads were attached to stems greater than 3 m in length, they were counted in the large woody debris category. Watershed Consulting used Forest Service R1/R4 methods for counting LWD. This included woody debris pieces at least 3 meters in length or 2/3 bankfull width, and 4 inches in diameter, and within the active channel or influenced by bank full flows.

Results: Other Data

Table F-7. LWD Summary for Mainstem Prospect Creek, WWP Reaches 1-7

Parameter	Average*	Other LCFR Tributaries	Relative to Other LCFR Tributaries
Large woody debris (pieces/mile)	55	182	-127
Small woody debris (pieces/mile)	36	158	-122
Woody Debris Aggregations (pieces/mile)	9	23	-13
Rootwads (pieces/mile)	0.8	47	-39
*Values are averages of WWP Reaches 1 -7.			

Reference: WWP, 1996

Table F-8. LWD Frequency in the Prospect Creek Watershed

Water Body	Reach	Rosgen Stream Type	LWD >3.0 m (singles + aggs + RW) (pieces/mile) WWP, 1996	LWD > 3.0 m (singles + aggs) (pieces/mile) Watershed Consulting, 1999
Main Stem	2	D4/C4	153*	64
Main Stem	3	D4/C4	153*	46
Main Stem	4	D4/3	153*	60
Main Stem	5 (FS R3)	C	153*	57
Crow Creek	1	C3/4	250	--
Crow Creek	2	C3/4	250	--
*Value is for WWP Reach 4 which is approximately equal to RDG Reaches 2-5.				

Reference: WWP, 1996 and Watershed Consulting, 1999

Percent Surface Fines

Methods: TMDL Data

Evaluation of percent fines in spawning areas (typically pool tailouts) provides an indicator of spawning habitat conditions. A high percentage of inter-gravel fines in spawning areas is detrimental to fry development. Evaluation of percent fines in riffles provides an indicator of

macroinvertebrate life support. A high percentage of inter-gravel fines in riffles may be detrimental to macroinvertebrates.

Particle size distributions and percent surface fines (PSF) were derived from data collected by the RDG and USFS using Wolman Pebble counts at both riffle and pool cross sections (**Table F-9**). Values for 2 mm and 6.35 mm size classes were interpolated from cumulative percent-finer-than plots. The 49-point grid toss method was used by the USFS to estimate PSF in riffles and pool tailouts. (**Table F-9**).

Results: TMDL Data

Table F-9. Percent Surface Fines in Prospect Creek Watershed (2004)*

Water Body	Surveyor	Reach/ Cross Section	Rosgen Stream Type	Feature	Wolman Pebble Count		Median Grid Toss (% < 6.35 mm)
					% Fines < 2 mm	% Fines < 6.4 mm	
Main Stem	RDG	1 / 1	B3c/F3	riffle	10	13	--
Main Stem	RDG	1 / 2	B2-3c/F2-3	step/pool	6	12	--
Main Stem	RDG	1 / 2	B2-3c/F2-3	pool	13	15	--
Main Stem	RDG	2 / 1	D4	riffle	17	20	--
Main Stem	RDG	2 / 1	D4	pool	33	33	--
Main Stem	RDG	2 / 2	D4/C4	pool	31	31	--
Main Stem	RDG	2 / 3	C4	riffle	11	13	--
Main Stem	RDG	'Ref' C / 1	Ref C4	riffle	12	12	--
Main Stem	RDG	'Ref' C / 1	Ref C4	pool	18	19	--
Main Stem	RDG	'Ref' C / 2	Ref C4	riffle	7	8	--
Main Stem	RDG	'Ref' C / 2	Ref C4	pool	14	15	--
Main Stem	RDG	3 / 1	C3	riffle	0	1	--
Main Stem	RDG	3 / 2	D4	braid	6	6	--
Main Stem	RDG	3 / 3	D4	braid	7	11	--
Main Stem	RDG	3 / 4	C4	riffle	5	6	--
Main Stem	RDG	4 / 1	D4	braid	10	12	--
Main Stem	RDG	4 / 2	D3	braid	3	3	--
Main Stem	RDG	4 / 3	D4b	riffle	7	8	--
Main Stem	Lolo NF	5 / 1 (FS R4)	C	riffle	13	17	2.0
Main Stem	Lolo NF	5 / 2 (FS R4)	C	riffle	14	18	26.5
Main Stem	Lolo NF	5 / 2 (FS R4)	C	pool	13	18	6.1
Main Stem	Lolo NF	5 (FS R3)	C	riffle	3	5	4.1
Main Stem	Lolo NF	5 (FS R3)	C	pool	6	7	2.0
Main Stem	Lolo NF	6 (FS R1)	B	riffle	14	14	2.0
Main Stem	Lolo NF	6 (FS R1)	B	pool	12	16	4.1
Clear	RDG	1 / 1	C4	riffle	7	8	--
Clear	RDG	1 / 2	C4	riffle	8	10	--
Clear	RDG	1 / 2	C4	pool	15	17	--
Clear	RDG	2	B4c/F4b	step/pool	4	5	--
Clear	RDG	3	C4	riffle	9	12	--
Clear	RDG	3	C4	pool	46	46	--
Clear	RDG	4	D4	braid	30	35	--
Clear	RDG	4	D4	pool	8	8	--
Clear	Lolo NF	6 (FS R2)	C	riffle	5	7	4.1

Table F-9. Percent Surface Fines in Prospect Creek Watershed (2004)*

Water Body	Surveyor	Reach/ Cross Section	Rosgen Stream Type	Feature	Wolman Pebble Count		Median Grid Toss (% < 6.35 mm)
					% Fines < 2 mm	% Fines < 6.4 mm	
Clear	Lolo NF	8 (FS R2b)	C	riffle	17	20	4.1
Clear	Lolo NF	8 (FS R2b)	C	pool	21	23	0.0
Clear	Lolo NF	9	A/B	--	--	--	--
Clear	DEQ	C13CLER01			15	17	
Clear	DEQ	C13CLER02			39	40	
Dry	RDG	1	C4	riffle	16	20	--
Dry	RDG	2	A3	riffle	5	6	--
Dry	RDG	2 / 1	A3	pool	14	19	--
Dry	RDG	3	C4	riffle	17	17	--
Dry	RDG	3 / 1	C4	pool	28	28	--
Dry	RDG	4WF	D4b	braid	19	22	--
Dry	RDG	4WF	D4b	pool	23	37	--
Dry	RDG	4EF	D4b	braid	20	35	--
Dry	RDG	4EF	D4b	pool	49	58	--
Dry	RDG	5WF	Ref B4	riffle	16	18	--
Dry	RDG	5WF	Ref B4	pool	28	28	--
Dry	Lolo NF	3 (FS R1)	C4	riffle	16	18	12.2
Dry	Lolo NF	3 (FS R1)	C4	pool	38	46	61.2
Dry	Lolo NF	5EF	C4	riffle	31	37	4.1
Dry	Lolo NF	5EF	C4	pool	19	25	18.4
Dry	Lolo NF	5WF	B4	riffle	33	34	2.0
Dry	Lolo NF	5WF	B4	pool	16	19	16.3
Dry	DEQ	C13DRY01			21	23	
Wilkes	RDG	1	B4c	riffle	7	9	--
Wilkes	RDG	1	B4c	pool	19	20	--
Wilkes	RDG	2	C4	riffle	10	13	--
Wilkes	RDG	2	C4	pool	11	15	--
Wilkes	RDG	3	B4c	riffle	15	16	--
Wilkes	RDG	3	B4c	pool	12	24	--
Wilkes	Lolo NF	2 / 1	C4	riffle	19	19	8.2
Wilkes	Lolo NF	2 / 1	C4	pool	14	18	16.3
Wilkes	Lolo NF	2 / 2	C4	riffle	22	23	2.0
Wilkes	Lolo NF	2 / 2	C4	pool	22	27	8.2
Crow	Lolo NF	1		pool	9	13	--
Crow	Lolo NF	2 / 1	C3/4	riffle	11	14	6.1
Crow	Lolo NF	2 / 1	C3/4	pool	--	--	2.0
Crow	Lolo NF	2 / 2	C3/4	riffle	16	20	8.2
Crow	Lolo NF	1EF / 1	C4b	riffle	21	24	4.1
Crow	Lolo NF	1EF	C4b	pool	--	--	42.9
Crow	Lolo NF	1EF / 2	C4b	riffle	27	30	14.3
Crow	Lolo NF	1EF / 2	C4b	pool	61	65	--
Crow	Lolo NF	1WF / 1	C4b	riffle	34	38	6.1
Crow	Lolo NF	1WF / 1	C4b	pool	--	--	6.1
Crow	Lolo NF	1WF / 2	C4b	riffle	23	26	8.2
Crow	Lolo NF	1WF / 2	C4b	pool	13	15	--
Cooper	Lolo NF	1	F3	pool	--	--	32.7

Table F-9. Percent Surface Fines in Prospect Creek Watershed (2004)*

Water Body	Surveyor	Reach/ Cross Section	Rosgen Stream Type	Feature	Wolman Pebble Count		Median Grid Toss (% < 6.35 mm)
					% Fines < 2 mm	% Fines < 6.4 mm	
Cooper	Lolo NF	2 / 1 (FS R1)	B3c	riffle	5	8	4.1
Cooper	Lolo NF	2 / 2 (FS R1)	B3c	riffle	3	4	2.0
Cooper	Lolo NF	2 / 2 (FS R1)	B3c	pool	13	14	--
Cooper	Lolo NF	3 (FS R2)	C4/D4	riffle	13	20	0.0
Cooper	Lolo NF	3 (FS R2)	C4/D4	pool	--	--	14.3
Cooper	Lolo NF	4 (FS R3)	C4/B	riffle	22	26	10.2
Cooper	Lolo NF	4 (FS R3)	C4/B	pool	38	50	--
* Data was not collected for all reaches. Only those sites with PSF samples are listed in this table.							

Channel Morphology and Stability

Three channel assessments have been completed on Prospect Creek since 1992. Washington Water Power (WWP) completed a stream and fish habitat assessment between 1992 and 1994 as part of the *Lower Clark Fork River Tributary Survey* (WWP, 1996). Watershed Consulting, LLC (WC) completed a channel, fish habitat, and fish population assessment in 1999 (Watershed Consulting, 1999). RDG and USFS completed a comprehensive watershed assessment in 2003. The results of the 2003 assessment, which were summarized in RDG, 2004, are presented in the following section.

In 2003, channel morphology was assessed through channel cross sections, substrate particle distribution, departure analysis, and stream bank modifications. Channel morphology and stability is also related to stream temperature and bank erosion. Temperature data and results as related to channel morphology and riparian vegetation are discussed in Appendices F, J, and K. Stream bank erosion inventory and sediment quantification are presented in **Section 5.0.**

Channel Cross-Section Dimensions

Methods

Channel cross-section surveys were completed from the USGS gage station on Prospect Creek (Reach 1) upstream to the confluence of Twentythreemile Creek and Glidden Gulch (Reach 5). Cross-section surveys were also completed on major tributaries including Dry, Clear, Wilkes, Cooper and Crow creeks. The data collection protocol included surveys equivalent to Rosgen Level II existing stream condition and Level III channel departure analysis (Rosgen, 1996). Among the parameters determined from cross-section data were bankfull width, mean depth, and width-to-depth ration (**Table F-10**). For stream classification purposes, water surface slope through the cross section and width of the floodprone area (at 2 times maximum riffle depth for determining entrenchment ratio) were also measured. Sinuosity was determined from air photo interpretation.

Results

Table F-10. Channel Metrics in Prospect Creek Watershed

Water Body	Surveyors	Reach / Cross Section	Rosgen	Width (ft)	Mean Depth (ft)	W/D ratio	Feature	Existing Sinuosity	Entrenchment Ratio	Slope
Main Stem	RDG	1 / 1	B3c/F3	77.6	2.4	31.9	riffle	1.02	1.29	0.76
Main Stem	RDG	1 / 2	B2-3c/ F2-3	51.3	4.5	11.5	step/pool	1.02	--	1.43
Main Stem	RDG	2 / 1	D4	211.4	0.9	225.3	riffle	1.06	1.96	0.62
Main Stem	RDG	2 / 2		102.1			pool	1.04	3.43	0.83
Main Stem	RDG	2 / 3	C4	87.5	2.4	36.2	riffle	1.15	--	0.5
Main Stem	RDG	'Ref'C/1	C4	114.8	1.1	102.1	riffle	1.7	>2x	0.64
Main Stem	RDG	'Ref'C/2	C4	68.6	1.0	70.5	riffle	1.7	>2x	0.64
Main Stem	RDG	3 / 1	C3	61.7	2.0	30.4	riffle	1.12	--	0.47
Main Stem	RDG	3 / 2	D4	179.9	0.6	319.1	braid	1.09	1.95	1.63
Main Stem	RDG	3 / 3	D4	104.4	0.5	212.4	braid	1.05	1.77	1.11
Main Stem	RDG	3 / 4	C4	49.6	1.8	27.1	riffle/Ref C	1.46	8.06	0.66
Main Stem	RDG	4 / 1	D4	118.0	1.2	99.4	braid	1.03	2.54	1.42
Main Stem	RDG	4 / 2	D3	81.7	0.8	108.7	braid	1.08	3.18	1.18
Main Stem	RDG	4 / 3	D4b	83.1	0.8	103.8	riffle	1.15	--	2.07
Main Stem	LNF	5 / 1 (FS R4)	C	37.3	1.7	31.7	riffle	1.36	6.74	2.06
Main Stem	LNF	5 / 2 (FS R4)	C	40.9	1.3	31.4	riffle	1.36	2.13	2.06
Main Stem	LNF	5 (FS R3)	C	33.2	2.3	14.6	riffle	1.1	9.04	2.38
Main Stem	LNF	6 (FS R1)	B	32.1	2.3	13.8	riffle	1.04	2.02	2.72
Clear	RDG	1 / 1	C4	29.1	0.4	73.2	riffle	1.14	2.34	0.47
Clear	RDG	1 / 2	C4	34.6	1.0	34.8	riffle	1.14	2.72	0.48
Clear	RDG	2	B4c/F4b	26.5	1.9	13.7	step/pool	1.09	1.40	0.92
Clear	RDG	3	C4	38.8	1.2	32.3	riffle	1.5	1.57	0.62
Clear	RDG	4	D4	353.2	0.8	441.0	braid	1.05	1.06	0.50
Clear	LNF	1	C4/D4	--	--	--	--	1.12	--	--
Clear	LNF	2	C4/D4	--	--	--	--	1.12	--	--
Clear	LNF	3	C4/D4	--	--	--	--	1.24	--	--
Clear	LNF	4	C4/D4	--	--	--	--	1.32	--	--
Clear	LNF	5	F3	--	--	--	--	1.12	--	--
Clear	LNF	6 (FS R2)	C	36.8	1.4	25.8	riffle	1.3	5.43	0.5
Clear	LNF	7 (FS R2b)	B3/C3	20.9	1.5	13.6	Riffle	1.05	7.18	2.96
Clear	LNF	8	C	20.9	1.5	13.6	riffle	*	--	--
Clear	LNF	9	A/B	--	--	--	--	*	--	--
Dry	RDG	1	C4	27.7	1.2	23.6	riffle	1.4	>2x	0.80
Dry	RDG	2	A3	20.0	2.7	7.4	riffle	1.15	1.4	7.65
Dry	RDG	3	C4	27.5	0.7	39.8	riffle	1.7	1.09	1.20
Dry	RDG	4WF	D4b	71.3	0.3	229.7	braid	1.5	2.31	2.40
Dry	RDG	4EF	D4b	67.0	0.63	107.2	braid	1	2.30	2.40

Table F-10. Channel Metrics in Prospect Creek Watershed

Water Body	Surveyors	Reach / Cross Section	Rosgen	Width (ft)	Mean Depth (ft)	W/D ratio	Feature	Existing Sinuosity	Entrenchment Ratio	Slope
Dry	RDG	5WF	Ref B4	14.2	1.2	11.7	riffle	1.03	1.83	2.42
Dry	LNF	3	C4	20.8	1.7	12.6	riffle	1.13	--	--
Dry	LNF	5EF	C4	14.7	1.2	12.7	riffle	1.2	4.42	1.83
Dry	LNF	5WF	B4	13.0	1.9	7.0	riffle	1.02	13.3	3.57
Wilkes	RDG	1	B4c	13.4	1.3	10.5	riffle	1.07	1.72	1.89
Wilkes	RDG	2	C4	14.6	0.9	17.0	riffle	1.5	2.40	1.80
Wilkes	RDG	3	B4c	17.6	1.1	16.5	riffle	1.33	1.19	2.0
Wilkes	LNF	2 / 1	C4	17.8	1.0	17.8	riffle	1.23	2.31	2.1
Wilkes	LNF	2 / 2	C4	19.1	1.6	12.0	riffle	1.23	8.38	2.1
Crow	LNF	2 / 1	C3/4	28.9	1.4	20.5	riffle	1.14	4.6	2.2
Crow	LNF	2 / 2	C3/4	26.2	1.5	17.2	riffle	1.14	7.17	2.2
Crow	LNF	1EF / 1	C4b	19.3	1.2	16.7	riffle	*	3.09	3.82
Crow	LNF	1EF / 2	C4b	19.8	1.3	15.6	riffle	*	4.37	3.82
Crow	LNF	1WF / 1	C4b	17.7	1.5	12.0	riffle	*	9.89	2.24
Crow	LNF	1 / 2	C4b	17.9	1.5	12.2	riffle	*	8.38	2.24
Cooper	LNF	1	F3	--	--	--	--	1	--	--
Cooper	LNF	2 / 1	B3c	27.5	1.7	16.7	riffle	1.31	1.35	1.75
Cooper	LNF	2 / 2	B3c	30.5	1.4	21.3	riffle	1.31	1.87	1.75
Cooper	LNF	3	C4/D4	73.1	0.7	104.9	riffle	1.23	2.74	3.18
Cooper	LNF	4	C4/B	21.7	2.3	9.3	riffle	1.26	8.25	1.11
Cooper	LNF	5	B4/C	--	--	--	--	1.15	--	--
Cooper	LNF	6	C4/B	36.4	--	--	riffle, spot measurements	1.09	--	--
Cooper	LNF	6	C4/B	20.5	--	--	riffle, spot measurements	1.09	--	--
Cooper	LNF	7	B4 to C4	14.8	--	--	riffle, spot measurements	1.22	--	--
Cooper	LNF	8	A	--	--	--	--	1.23	--	--

--No value.
* Sinuosity difficult or impossible to measure due to dense vegeation cover and/or to stream size relative to photo scale.

Riffle Substrate Distribution

Methods

Wolman pebble counts were used by RDG and USFS to determine channel substrate particle size distribution in both riffles and pools. Pebble counts and cross sections are positioned at a location along the reach that is representative of conditions throughout the reach. They represent one sample along the length of a stream reach. A cumulative percent finer-than graph was generated

for each cross-section pebble count. For Wolman pebble counts in riffles, cumulative percent finer-than graphs were used to interpolate percent fines less than 6.35mm and less than 2mm (**Table F-11**).

Evaluation of percent fines in spawning areas (typically pool tailouts) provides an indicator of spawning habitat conditions. A high percentage of inter-gravel fines in spawning areas is detrimental to fry development. Evaluation of percent fines in riffles provides an indicator of macroinvertebrate life support. A high percentage of inter-gravel fines in riffles may be detrimental to macroinvertebrates.

The Riffle Stability Index was also evaluated (Kapperser, 2002). The length of the median axis was recorded for each of the thirty largest mobile particles on the lower 1/3 of a point bar near each riffle cross section, if a point bar could be located. The geometric mean of the thirty largest bar particles was calculated and compared to the d50 from the riffle pebble count distribution. The RSI value is the percent-finer than value from the riffle percent-finer than distirubtuion curve that corresponds to the geometric mean particle size of the bar particles. High RSI values occur when a portion of channel substrate (d50 of the riffle) is smaller than the average bar particle, indicating excess sediment loading. Low RSI values occur when a small portion of the the channel substrate is finer than the average bar particle indicating channel scour. Moderate RSI values occur when a moderate portion of the channel substrate is smaller than the average bar particle indicating dynamic equilibrium (Kappesser, 2002).

Results

Table F-11 Substrate Distribution in Prospect Creek Watershed*

Waterbody	Surveyors	Reach	Rosgen	Feature	d50	% Fines < 2	% Fines < 6.4	Mean Bar (mm)	% Finer Than RSI
Main Stem	RDG	1 / 1	B3c/F3	riffle	56.7	10	13	--	--
Main Stem	RDG	1 / 2	B2-3c / F2-3	step/pool	273.9	6	12	--	--
Main Stem	RDG	1 / 2	B2-3c / F2-3	pool	124.4	13	15	--	--
Main Stem	RDG	2 / 1	D4	riffle	34.4	17	20	105	97
Main Stem	RDG	2 / 1	D4	pool	10.8	33	33	--	--
Main Stem	RDG	2 / 2	D4/C4	pool/ braid	28.5	31	31	118	98
Main Stem	RDG	2 / 3	C4	riffle	44.1	11	13	--	
Main Stem	RDG	‘Ref" C / 1	Ref C4	riffle	41.2	12	12	162	96
Main Stem	RDG	‘Ref" C / 1	Ref C4	pool	29.7	18	19	--	--
Main Stem	RDG	‘Ref" C / 2	Ref C4	riffle	46.2	7	8	171	98
Main Stem	RDG	‘Ref" C / 2	Ref C4	pool	31.0	14	15	--	--
Main Stem	RDG	3 / 1	C3	riffle	66.8	0	1	--	--
Main Stem	RDG	3 / 2	D4	braid	56.3	6	6	211	97
Main Stem	RDG	3 / 3	D4	braid	57.0	7	11	148	90
Main Stem	RDG	3 / 4	C4	riffle	48.0	5	6	--	--
Main Stem	RDG	4 / 1	D4	braid	52.0	10	12	161	85
Main Stem	RDG	4 / 2	D3	braid	97.4	3	3	224	89
Main Stem	RDG	4 / 3	D4b	riffle	128.0	7	8	194	77
Main Stem	LNF	5 / 1 (FS R4)	C	riffle	75.2	13	17	--	--
Main Stem	LNF	5 / 2 (FS R4)	C	riffle	53.9	14	18	--	--
Main Stem	LNF	5 / 2 (FS R4)	C	pool	49.6	13	18	--	--
Main Stem	LNF	5 (FS R3)	C	riffle	103.2	3	5	174	78
Main Stem	LNF	5 (FS R3)	C	pool	96.0	6	7	--	--
Main Stem	LNF	6 (FS R1)	B	riffle	91.3	14	14	--	--
Main Stem	LNF	6 (FS R1)	B	pool	59.1	12	16	--	--

Table F-11 Substrate Distribution in Prospect Creek Watershed*

Waterbody	Surveyors	Reach	Rosgen	Feature	d50	% Fines < 2	% Fines < 6.4	Mean Bar (mm)	% Finer Than RSI
Clear	RDG	1 / 1	C4	riffle	26.6	7	8	--	--
Clear	RDG	1 / 2	C4	riffle	37.3	8	10	--	--
Clear	RDG	1 / 2	C4	pool	41.6	15	17	--	--
Clear	RDG	2	B4c/F4b	step/pool	38.3	4	5	--	--
Clear	RDG	3	C4	riffle	30.3	9	12	78	97
Clear	RDG	3	C4	pool	12.0	46	46	--	--
Clear	RDG	4	D4	braid	14.6	30	35	95	98
Clear	RDG	4	D4	pool	24.0	8	8	--	--
Clear	LNF	6 (FS R2)	C	riffle	83.2	5	7	125	65
Clear	LNF	8 (FS R2b)	C	riffle	59.6	17	20	112	24
Clear	LNF	8 (FS R2b)	C	pool	66.5	21	23	--	--
Clear	DEQ	C13CLER01			37.3	15	17	--	--
Clear	DEQ	C13CLER02			25.1	39	40	--	--
Dry	RDG	1	C4	riffle	38.5	16	20	84	80
Dry	RDG	2	A3	riffle	73.3	5	6	--	--
Dry	RDG	2 / 1	A3	pool	51.6	14	19	--	--
Dry	RDG	3	C4	riffle	35.8	17	17	121	93
Dry	RDG	3 / 1	C4	pool	22.0	28	28	--	--
Dry	RDG	4WF	D4b	braid	38.7	19	22	--	--
Dry	RDG	4WF	D4b	pool	19.6	23	37	--	--
Dry	RDG	4EF	D4b	braid	7.8	20	35	--	--
Dry	RDG	4EF	D4b	pool	2.4	49	58	--	--
Dry	RDG	5WF	Ref B4	riffle	58.7	16	18	--	--
Dry	RDG	5WF	Ref B4	pool	13.9	28	28	--	--
Dry	LNF	3 (FS R1)	C4	riffle	56.7	16	18	70	68
Dry	LNF	3 (FS R1)	C4	pool	56.7	38	46	--	--
Dry	LNF	EF	C4	riffle	56.7	31	37	108	92
Dry	LNF	EF	C4	pool	27.2	19	25	--	--

Table F-11 Substrate Distribution in Prospect Creek Watershed*

Waterbody	Surveyors	Reach	Rosgen	Feature	d50	% Fines < 2	% Fines < 6.4	Mean Bar (mm)	% Finer Than RSI
Dry	LNF	WF	B4	riffle	29.4	33	34	--	--
Dry	LNF	WF	B4	pool	36.3	16	19	--	--
Wilkes	RDG	1	B4c	riffle	58.6	7	9	--	--
Wilkes	RDG	1	B4c	pool	32.0	19	20	--	--
Wilkes	RDG	2	C4	riffle	41.5	10	13	122	81
Wilkes	RDG	2	C4	pool	34.5	11	15	--	--
Wilkes	RDG	3	B4c	riffle	60.7	15	16	--	--
Wilkes	RDG	3	B4c	pool	49.4	12	24	--	--
Wilkes	LNF	2 / 1	C4	riffle	43	19	19	--	--
Wilkes	LNF	2 / 1	C4	pool	45.9	14	18	--	--
Wilkes	LNF	2 / 2	C4	riffle	44.6	22	23	105	77
Wilkes	LNF	2 / 2	C4	pool	19.8	22	27	--	--
Crow	LNF	1		pool	48.6	9	13	--	--
Crow	LNF	2 / 1	C3/4	riffle	57.0	11	14	--	--
Crow	LNF	2 / 2	C3/4	riffle	49.0	16	20	--	--
Crow	LNF	1EF / 1	C4b	riffle	43.7	21	24	--	--
Crow	LNF	1EF / 2	C4b	riffle	27.7	27	30	--	--
Crow	LNF	1EF / 2	C4b	pool	0.4	61	65	--	--
Crow	LNF	1WF / 1	C4b	riffle	18.3	34	38	112	71
Crow	LNF	1WF / 2	C4b	riffle	51.6	23	26	--	--
Crow	LNF	1WF / 2	C4b	pool	36.6	13	15	--	--
Cooper	LNF	2 / 1 (FS R1)	B3c	riffle	96	5	8	--	--
Cooper	LNF	2 / 2 (FS R1)	B3c	riffle	106.3	3	4	--	--
Cooper	LNF	2 / 2 (FS R1)	B3c	pool	54.44	13	14	--	--
Cooper	LNF	3 (FS R2)	C4/D4	riffle	28.29	13	20	119	98
Cooper	LNF	4 (FS R3)	C4/B	riffle	36.45	22	26	116	77
Cooper	LNF	4 (FS R3)	C4/B	pool	6	38	50	--	--

* Data was not collected for all sample reaches. Only those sites with LWD samples are listed in this

Table F-11 Substrate Distribution in Prospect Creek Watershed*

Waterbody	Surveyors	Reach	Rosgen	Feature	d50	% Fines < 2	% Fines < 6.4	Mean Bar (mm)	% Finer Than RSI
table.									

Channel Departure Analysis

Methods

RDG evaluated 1947 and 2000 aerial photos to measure meander geometry dimensions and identify factors influencing channel form and function. Meander geometry dimensions including bankfull width, sinuosity, meander length, meander belt width, and radius of curvature were measured to evaluate stream type changes resulting from direct and indirect channel modifications as well as riparian vegetation changes. Channel length reductions associated with highway construction and with channel adjustments were also measured.

Results

Table F-12 summarizes bankfull width, meander length, sinuosity, meander belt width, and radius of curvature measured from the 1947 and 2000 photos. A more detailed presentation of data results for Reaches 3 and 4 can be found in Tables 3-15 and 3-19 respectively in the Phase I TMDL document (RDG, 2004). **Table F-13** summarizes results of channel length analysis for mainstem Prospect Creek from 1947 to 2000.

Table F-12. Summary of Plan Form Geometry for Mainstem Prospect Creek, Reaches 1 through 5, from 1947 to 2000

Reach	Dominant Channel Type	Bankfull channel width (ft)		Meander Length (ft)		Sinuosity		Meander Belt Width (ft)		Radius of Curvature (ft)	
		1947	2000	1947	2000	1947	2000	1947	2000	1947	2000
1	B	*	65	*	802	1.11	1.11	*	208	*	413
2	C-D	141	163	610	893	1.15	1.06	279	401	214	275
3	C-D	126	148	714	1149	1.25	1.14	250	423	273	400
4	C-D	60	68	843	887	1.16	1.08	304	307	289	336
5	B	*	24	583	508	1.17	1.11	233	122	164	199
* Sufficient aerial photos not available.											

Table F-13. Channel Length Analysis Results for Mainstem Prospect Creek from Evans Gulch Downstream to Clear Creek

Photo Series	Channel Length [feet (miles)]	Cause and Channel Length Reduction		
		Highway Construction	Channel Adjustments	
1947	110,074 (20.8)	2,748 ft	5,242 ft	
2000	102,084 (19.3)			

Streambank Modifications

Methods

During 2003, the length of Prospect Creek mainstem was inventoried for streambank modifications. Location, length, and type were noted for each streambank modification observed. Types of modifications observed include rip rap, rootwads and other native material revetments, channel structures and combinations thereof.

Streambank modifications were also catalogued by the Green Mountain Conservation District based on 310 permit applications. A comprehensive list of approved applications to date is provided in **Table F-14** including permit number, applicant, and description of activity. (GMCD, 2005)

Table F-14. 310 Permits Issued by Green Mountain Conservation District for Streambank Modification/Alteration

Permit #	Applicant	Description
SW-03-76	YPL	Recover pipe
SW-07-81	YPL	Install gabions & riprap
SW-09-81	Silver Star Mines	Bulldozen channel away from power line
SW-02-82	Wilkinson	Diversion for Hydro-electric plant
SW-06-82	YPL	Lower exposed pipeline
SW-02-83	YPL	Lower pipeline
SW-06-87	Hagaman Logging	Stream bed crossing
SW-22-88	Dwyer	Timber removal and bridge construction
SW-02-89	Dwyer	Timber thinning; bridge construction
SW-10-90	Baxter	Bank stabilization with riprap
SW-12-90	Kirk Bay	Logging truck crossing
SW-16-90	YPL	Pipeline maintenance
SW-19-90	Dwyer	Construction clean-up
SW-32-93	J&N Harvesting	Set railroad car
SW-36-93	Dwyer	Temporary bridge
SW-37-93	Kraak	Hillside logging
SW-39-93	Hensyel	Haul logs across streambed
SW-01V-94	Dwyer	Tree removal
SW-22-94	Birchard	Power generating structure
SW-47-94	Reed	Haul logs across streambed
SW-02-95	Ahlf	Bridge replacement
SW-03E-95	YPL	Emergency bank stabilization
SW-03-96	YPL	Bank stabilization
SW-04-96	YPL	Bank stabilization
SW-05-96	YPL	Bank stabilization
SW-06-96	Anderson	Bank stabilization
SW-07-96	MT Power	Bank stabilization
SW-23E-96	YPL	Emergency sand bagging
SW-25-96	YPL	Bank stabilization
SW-26-96	YPL	Bank stabilization
SW-27-96	YPL	Bank stabilization
SW-28-96	YPL	Bank stabilization
SW-29-96	YPL	Bank stabilization
SW-30-96	YPL	Bank stabilization
SW-43-96	YPL	MP 435.5 maintenance
SW-44-96	YPL	MP 428.7 & 428.8 maintenance
SW-50-96	YPL	MP 421.5 maintenance
SW-07-97	YPL	MP 424.6 maintenance
SW-08-97	YPL	MP 424.9 maintenance
SW-10E-97	YPL	MP 420.4 maintenance
SW-11E-97	YPL	MP 421.3 maintenance
SW-50-97	YPL	MP 420.3 maintenance
SW-51-97	YPL	MP 420.9 maintenance

Table F-14. 310 Permits Issued by Green Mountain Conservation District for Streambank Modification/Alteration

Permit #	Applicant	Description
SW-52-97	YPL	MP 423.7 maintenance
SW-53-97	YPL	MP 423.8 maintenance
SW-54-97	YPL	MP 428.7 maintenance
SW-55-97	YPL	MP 434.7 maintenance
SW-56-97	YPL	MP 434.8 maintenance
SW-67-97	MT Power	Remover power pole
SW-05-98	Merritt	Pond
SW-11E-98	MT Power	Emergency tree removal
SW-13-98	MT Power	Power lines
SW-31-98	YPL	Pipe stabilization
SW-32-98	YPL	Bank stabilization
SW-33-98	YPL	MP 429.4 maintenance
SW-34-98	YPL	MP 429.5 maintenance
SW-35-98	YPL	MP 432.7 maintenance
SW-36-98	YPL	MP 432.9 maintenance
SW-07A-99	PCWC	(Phase 1) Bank stabilization and alteration
SW-07B-99	PCWC	(Phase 1) Bank stabilization and alteration
SW-07C-99	PCWC	(Phase 1) Bank stabilization and alteration
SW-07D-99	PCWC	(Phase 1) Bank stabilization and alteration
SW-07E-99	PCWC	(Phase 1) Bank stabilization and alteration
SW-12A-99	PCWC	(Phase 2) Bank stabilization and alteration
SW-12B-99	PCWC	(Phase 2) Bank stabilization and alteration
SW-12C-99	PCWC	(Phase 2) Bank stabilization and alteration
SW-12D-99	PCWC	(Phase 2) Bank stabilization and alteration
SW-12E-99	PCWC	(Phase 2) Bank stabilization and alteration
SW-04-00	Touch America	Fiber Optic Utilities
SW-08A-00	PCWC	Bank stabilization; channel alteration
SW-08B-00	PCWC	Bank stabilization; channel alteration
SW-08C-00	PCWC	Bank stabilization; channel alteration
SW-08D-00	PCWC	Bank stabilization; channel alteration
SW-27V-00	Unknown	
SW-40-00	MPC	Temporary stream crossing
SW-42-00	Flamming	Bank stabilization; channel alteration
SW-45-00	Cheetham	Bank stabilization
SW-01-01	YPL	Misc. stream work
SW-02-01	Reed/Reeser	Temporary stream crossing
SW-32-01	Dwyer	Temporary stream crossing
SW-27-02	YPL	Pipeline re-route
SW-32-02	Cheetham	Irrigation structure
SW-38-02	NW Energy	Power poles
SW-16-04	YPL	Channel alteration
SW-16C-05	Olney	Unpermitted posts
SW-03V-06	Olney	Fence posts
SW-27-06	Stuckey	Irrigation structure
SW-32-06	Olney	Boundry posts
SW-43C-06	Olney	Irrigation structure
Last two digits in permit number denote year of issuance		

The methods and results of assessing sediment sources in the Prospect Creek watershed is discussed in detail in **Section 5.0**. One portion of the sediment source assessment includes an inventory of stream bank erosion and related land uses possibly influencing bank erosion.

Results

Approximately 6,655 linear feet of rip-rap, 2,100 linear feet of rip-rap with rootwads, and 1,800 linear feet of native material bank stabilization techniques have been installed in Reaches 1-4 on the mainstem Prospect (**Table F-15**). An additional 19 rock channel structures have been installed to reduce bank erosion and protect pipeline infrastructure from channel bed scour. Numerous gabion baskets have also been installed. **Table F-15** summarizes the type and total length of inventoried bank stabilization treatments on Prospect Creek. Gabion retaining walls in Reach 5 were not recorded in detail and have been omitted from the summary table.

Table F-15. Type and Total Length of Inventoried Bank Stabilization Treatments on Prospect Creek by Stream Reach (in feet)

Type	Reach 1	Reach 2	Reach 3	Reach 4
Rip-rap	0	3825	2230	600
Rip-rap with rootwads	0	1100	1000	0
Native material*	0	1450	350	0
Channel structures†	0	11	8	0

* Includes tree and rootwad revetment structures coupled with site revegetation
† Includes number of individual rock vane and barb structures

Riparian Vegetation Assessment

Methods

Canopy density analysis for the mainstem Prospect Creek was completed using the 1996 aerial photo series at a scale of 1 inch equals 300 feet. The analysis included reaches 2 through 5 and did not include Reach 1, a higher gradient B channel. Reach 1 is characterized by a confined channel in a steep canyon that terminates at the confluence with the Clark Fork River. It is unlikely that temperature or shading issues are present in this initial reach, although future temperature monitoring is recommended. Sampling locations were established in each stream reach, at equal intervals, enabling a minimum of 30 measurements. A map wheel determined exact sampling locations along the mainstem where a planimeter-type grid, one inch square, with 41 holes was overlain on selected sites. This grid was orientated perpendicular to valley aspect, and encompassed the adjacent floodplain and bankfull channel with plot size determined by local meander belt width. When increased belt widths occurred, the grid size was enlarged to meet the additional area. The grid size was narrowed when the belt width decreased.

Within each selected site, the percent of forested (mature forest and thick willow/alder) land was derived by tallying the number of dots overlying forested areas and dividing by the total number of dots within the plot. Each site was mapped and numbered on the relevant aerial photo.

On August 30, 2005, Montana DEQ collected field measurements of riparian canopy density at some of the aerial photo sample sites using the EMAP method (Lazorchak et. al., 1998). A

densitometer was used to measure canopy shading the stream at three cross-sections within the aerial photo sample site. Cross sections were located in the middle of aerial photo sample site, at an upstream location within the site each site, and at a downstream location with the site. For each cross-section, a densitometer reading was taken at the left bank, the right bank, and in the middle of the channel. All readings were taken with the densitometer at 1 foot above the water surface,

All values were averaged to determine canopy density for the aerial photo site according to a conversation with Heidi Lindgren in 2005.

Table F-16 presents the results of the canopy density aerial photo analysis on the mainstem of Prospect Creek. **Table F-17** includes the results of the DEQ field analysis and comparison with the aerial assessment.

Results

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
2	1	2	150	pvt	NWE	highway		shrub/ small trees	pvt				shrub/ small trees	46
2	2	2	220	pvt	NWE	road	highway	mature trees	pvt	NWE	Restoration attempt		shrub/ small trees	47
2	3	1	100	pvt	highway			shrub/ small trees	pvt				shrub/ small trees	39
2	4	1	120	pvt	highway			bare ground/ grass/ shrub	pvt	road			bare ground/ grass	27
2	5	1	210	pvt	highway			bare ground/ grass/ shrub	pvt	BPA			shrub/ small trees	30
2	6	2	150	pvt	BPA	highway		mature trees	pvt	BPA			shrub/ small trees	68
2	7	1	130	USFS	highway			shrub/ small trees	fs	YPL (original)	NWE	road	shrub/ small trees	74
2	8	2	150	fs	highway			shrub/ small trees	fs				shrub/ small trees	74
2	9	1	90	fs	highway			bare ground/ grass	fs				mature trees	71
2	10	3	300	pvt	highway			shrub/ small trees	pvt	YPL (original)	NWE		shrub/ small trees	41
2	11	1	150	pvt	highway			shrub/ small trees	pvt	YPL (original)			shrub/ small trees	52
2	12	1	150	pvt	highway			bare ground/ grass	pvt	YPL (original)			shrub/ small trees	58

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
2	13	2	180	pvt	highway			bare ground/ grass	pvt	YPL (original)			shrub/ small trees	64
2	14	3	210	pvt	highway			shrub/ small trees	pvt	YPL (original)			grass/ shrub	44
2	15	1	165	pvt	highway			grass/ shrub/ small trees	pvt	YPL (original)			shrub/ small trees	39
2	16	1	100	pvt	highway			bare ground/ grass	pvt	YPL (original)	NWE		shrub/ small trees	68
2	17	3	300	pvt	NWE	highway		bare ground/ grass/ shrub	pvt	YPL (original)	NWE		shrub/ small trees	61
2	18	1	135	pvt	YPL (original)			mature trees	pvt				mature trees	77
2	19	1	150	pvt	road			mature trees	pvt	road			shrub/ small trees	74
2	20	1	150	pvt	road			shrub/ small trees	pvt	road			mature trees	68
2	21	2	150	pvt				shrub/ small trees	pvt	road			shrub/ small trees	81
2	22	2	170	pvt	residence			shrub/ small trees	pvt	residence	riparian development		bare ground/ grass	52
2	23	3	120	pvt				shrub/ small trees	pvt				mature trees	64
2	24	4	350	pvt	riparian development	road	residence	bare ground/ grass/ shrub	pvt				mature trees	55
2	25	2	225	pvt				shrub	pvt				shrub/	63

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
													small trees	
2	26	2	350	pvt	residence	highway	NWE	shrub	pvt				shrub/ small trees	49
2	27	1	120	pvt	highway	NWE		shrub/ small trees	pvt				mature trees	49
2	28	1	210	pvt	highway	NWE		bare ground/ grass/ shrub	pvt				mature trees	37
2	29	3	200	pvt	highway	NWE		shrub	pvt				shrub/ small trees	51
2	30	2	375	pvt	residence	riparian development		shrub/ small trees	pvt				shrub/ small trees	60
2	31	1	225	pvt				small trees	pvt				shrub/ mature trees	68
3	1	1	120	pvt				shrub/ small trees	pvt				mature trees	77
3	2	2	300	pvt	residence	riparian development		grass/ shrub/ small trees	pvt				shrub/ small trees	49
3	3	1	150	fs/ pvt				shrub/ small trees	fs/ pvt				mature trees	72
3	4	1	120	fs	YPL (original)	highway	YPL (re-route)	bare ground/ grass/ shrub	fs	YPL (original)			shrub/ small trees	54
3	5	1	180	fs	YPL (original)			grass/ shrub/ small trees	fs	YPL (original)			shrub/ small trees	61
3	6	3	90	pvt				shrub/ small trees	pvt				shrub/ small trees	68
3	7	1	100	fs	pasture			grass/ shrub/	fs				mature	21

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
								small trees					trees	
3	8	2	300	pvt	YPL (original)	NWE	riparian development	grass/ shrub/ small trees	pvt				shrub/ small trees	59
3	9	2	160	fs	YPL (original)	NWE		shrub/ small trees	fs				mature trees	54
3	10	1	225	pvt	highway	YPL (re-route)		bare ground/ grass	fs	NWE	YPL (original)		bare ground/ grass/ shrub/ mature trees	56
3	11	2	120	fs	YPL (original)	NWE		shrub/ small trees	fs				shrub/ small trees	76
3	12	2	190	pvt				shrub/ small trees	pvt				mature trees	72
3	13	2	375	pvt	residence	NWE	YPL (re-route)	bare ground/ grass/ shrub	pvt				shrub/ small trees	35
3	14	1	95	pvt				shrub/ small trees	pvt				mature trees	75
3	15	2	135	pvt				geadss/ shrub/ small trees	pvt				mature trees	66
3	16	3	110	pvt				shrub/ small trees	pvt				mature trees	71
3	17	2	120	fs	pasture			bare ground/ grass/ shrub	fs				mature trees	43
3	18	2	150	fs				mature trees	fs				shrub/	74

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
													mature trees	
3	19	1	225	fs	NWE	highway	YPL (re-route)	grass/ mature trees	fs	NWE	YPL (original)		grass/ shrub/ small trees	58
3	20	2	225	fs	highway	YPL (re-route)		bare ground/ grass/ shrub	fs	NWE			bare/ shrub/ small trees	64
3	21	1	100	fs	NWE	YPL (original)	road	bare ground/ grass	fs	road			mature trees	39
3	22	1	200	fs	YPL (original)			bare ground/ grass/ shrub	fs	NWE			shrub/ small trees	38
3	23	1	120	pvt	road	residence	riparian development	grass/ shrub/ small trees	pvt				small/ mature trees	31
3	24	1	95	fs	highway	YPL (re-route)		bare ground/ grass	fs	NWE			shrub/ small trees	45
3	25	1	210	fs	NWE	YPL (original)		shrub/ small trees	fs	NWE	YPL (original)		shrub/ small trees	58
3	26	2	190	fs	NWE	YPL (re-route)	highway/ BPA	shrub/ small trees	fs	NWE			grass/ shrub/ small trees	56
3	27	1	150	fs	YPL (original)			shrub/ small trees	fs				shrub/ small trees	65
3	28	1	120	fs				bare ground/ grass/ shrub	fs	YPL (original)	YPL (original)		grass/ shrub/ small trees	64
3	29	1	100	fs				bare ground/	fs	YPL			grass/	44

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
								grass/ shrub		(original)			shrub/ small trees	
3	30	2	75	fs				shrub/ small trees	fs				shrub/ mature trees	71
3	31	3	65	fs				bare ground/ grass/ shrub	fs				shrub/ small trees	42
3	32	1	150	fs	fire			grass/ shrub/ small trees	fs	fire			shrub/ small trees	47
4	1	2	250	fs				bare ground/ grass	fs				mature trees	25
4	2	3	180	fs				bare ground/ grass/ shrub	fs				grass/ mature trees	32
4	3	3	250	fs				shrub/ small trees	fs	YPL (original)			grass/ shrub/ small trees	34
4	4	1	180	fs				shrub/ mature trees	fs	YPL (original)			shrub/ shrub/ small trees	46
4	5	2	195	fs				shrub/ small trees	fs	YPL (original)			grass/ shrub	26
4	6	3	225	fs				grass/ shrub/ small trees	fs	YPL (original)			grass/ shrub/ small trees	18

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
4	7	3	300	fs					fs	YPL (original)	road	riparian development	bare/ grass/ shrub	17
4	8	2	300	fs				bare ground/ grass/ shrub	fs	road	YPL (original)	NEW	bare/ grass/ shrub	14
4	9	2	300	fs				mature trees	fs	road	NWE	YPL (original)	grass/ shrub/ small trees	25
4	10	2	270	fs				shrub/ mature trees	fs	road	NWE	YPL (original)	grass/ shrub	31
4	11	2	200	fs				mature trees	fs	road	NWE	YPL (original and re-route)	grass/ shrub	25
4	12	1	225	fs	riparian development			grass/ shrub/ small trees	fs	riparian development	NWE	YPL (original and re-route)	bare/ grass/ shrub	28
4	13	1	120	fs				shrub/ small trees	fs				shrub/ small trees	46
4	14	2	70	fs	road			bare ground/ grass/ shrub	fs	road			shrub/ mature trees	44
4	15	1	90	fs				grass/ shrub/ small trees	fs				grass/ shrub/ small trees	39
4	16	1	105	fs				mature trees	fs				shrub/ small trees	41
4	17	1	120	fs				mature trees	fs				mature trees	54
4	18	2	135	fs				mature trees	fs				mature	39

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
													trees	
4	19	2	115	fs				mature trees	fs				mature trees	52
4	20	1	115	fs				mature trees	fs				mature trees	61
4	21	1	135	fs				mature trees	fs	YPL (original)	road	highway	shrub/ small trees	34
4	22	1	90	fs				mature trees	fs	YPL (original)	road		grass/ mature trees	61
4	23	2	75	fs				mature trees	fs				mature trees	90
4	24	1	65	fs				mature trees	fs				mature trees	90
4	25	1	75	fs				mature trees	fs				mature trees	71
4	26	2	90	fs				mature trees	fs				grass/ mature trees	63
4	27	2	110	pvt	riparian clearing	road		bare ground/ grass/ shrub	pvt	riparian development			grass/ shrub/ small trees	32
4	28	2	105	fs				mature trees	fs				mature trees	76
4	29	2	150	fs				shrub/ small trees	fs	YPL (original)			mature trees	49

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
4	30	2	190	fs				shrub/ small trees	fs	YPL (original)			shrub/ small trees	40
5	1	1	40	pvt	YPL (original)			mature trees	pvt	riparian development	road	YPL (original)	mature trees	59
5	2	2	80	fs/ pvt	riparian clearing	road		grass/ shrub	fs/ pvt	YPL (original)			shrub/ mature trees	53
5	3	1	60	fs				mature trees	fs	YPL (original)	YPL (re-route)		mature trees	56
5	4	1	50	fs				mature trees	fs				shrub/ mature trees	53
5	5	1	75	fs				mature trees	fs				shrub/ small trees	50
5	6	2	50	fs				mature trees	fs				mature trees	57
5	7	1	40	fs				bare ground/ grass/ mature trees	fs				mature trees	43
5	8	2	40	fs				mature trees	fs				shrub/ small trees	50
5	9	1	45	fs				mature trees	fs				mature trees	61
5	10	2	90	fs				mature trees	fs	YPL (original)	highway	YPL (re-route)	grass/ shrubs/ mature	56

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
													trees	
5	11	1	75	fs				shrub/ small trees	fs	YPL (original)	highway	YPL (re-route)	grass/ shrub/ small trees	16
5	12	1	75	fs				shrub/ small trees	fs	YPL (original)			shrub/ small trees	31
5	13	2	100	fs	YPL (original)			shrub/ small trees	fs	YPL (original)	highway		shrub/ small trees	53
5	14	1	90	fs				mature trees	fs	YPL (original)	highway	YPL (re-route)	grass/ shrub/ small trees	53
5	15	1	90	fs	YPL (original)	highway	YPL (re-route)	bare ground/ grass/ shrub	fs	YPL (original)	YPL (re-route)	highway	shrub/ small trees	30
5	16	1	30	fs	YPL (original)			grass/ small trees	fs				mature trees	57
5	17	1	30	fs				mature trees	fs				mature trees	87
5	18	1	20	fs				mature trees	fs				mature trees	87
5	19	1	25	fs				shrub/ mature trees	fs				mature trees	74
5	20	1	45	fs	YPL (original)	highway	YPL (re-route)	grass/ mature trees	fs				mature trees	78
5	21	1	20	fs	YPL (original)	highway	YPL (re-route)	bare ground/ grass	fs				mature trees	50

Table F-16. Land Ownership, Land Uses, and Vegetation Class Associated with Percent Canopy Derived from 1996 Aerial Photo Interpretation Reported in RDG 2004

				Left Bank					Right Bank					
Reach	Site	# of Threads	Total Active Channel Width (feet)	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Land Owner	Land Use 1	Land Use 2	Land Use 3	Vegetation	Percent Canopy
5	22	1	20	fs	YPL (original)	highway	YPL (re-route)	grass/ shrub/ small trees	fs				mature trees	50
5	23	1	20	fs	YPL (original)	highway	YPL (re-route)	grass/ shrub/ small trees	fs				mature trees	64
5	24	1	55	fs	highway	YPL (re-route)		bare ground/ grass	fs	YPL (original)			shrub/ small trees	43
5	25	1	30	fs	highway	YPL (re-route)		bare ground/ grass/ shrub	fs	YPL (original)			shrub/ mature trees	50
5	26	1	30	fs	highway	YPL (re-route)		bare ground/ grass/ shrub	fs	YPL (original)			shrub/ small trees	50
5	27	2	45	fs	YPL (original)			shrub/ small trees	fs	YPL (original)			mature trees	43
5	28	1	25	fs	YPL (original)	highway	YPL (re-route)	grass/ shrub/ small trees	fs				mature trees	57
5	29	1	20	fs	highway	YPL (original)		grass/ mature trees	fs				mature trees	71
5	30	1	25	fs				shrub/ small trees	fs				mature trees	64
5	31	1	20	fs				mature trees	fs				mature trees	71

Table F-17. Comparison of DEQ field data and aerial photo canopy density analysis on mainstem of Prospect Creek

Reach-Site	Field Canopy Cover (%)	Aerial Photo Canopy Cover (%)	Field # of Threads	Aerial Photo # of Threads	Field LB Vegetation	Field RB Vegetation	Aerial Photo LB Vegetation	Aerial Photo RB Vegetation	Total Active Channel Width*
2-4	8	27	1	1	small trees/ brush/grass on gravel bars	small trees/ brush/grass on gravel bars	bare ground/ grass	bare ground/ grass	120
2-8	12	74	Middle xsection:2 Up and Down xsections:1	2	brush/small tree	brush/small tree	shrub/ small trees	shrub/ small trees	150
2-11	19†	52	Upper and Middle xsections:2 Down stream xsection:1	1	road/brush/ grass	small trees/brush	shrub/ small trees	shrub/ small trees	150
2-29	28§	51	1	3	bare/grass	mature tree	shrub/ mall trees	shrub/ small trees	200
3-10	13	56	1	1	rx/grass/ small trees	rx/grass	bare ground/ grass	bare ground/ grass	225
3-11	41	76	1	2	grass/shrub/ small trees	trees	shrub/ small trees	shrub/ small trees	120
3-25	8∞	58	1 active	1	grass/shrub/ small trees	grass/shrub/ small trees	shrub/ small trees	shrub/ small trees	210
3-26	34	56	1	2	grass/shrub/ small trees	mature tree	shrub/ small trees	shrub/ small trees	190
4-21	34	34	DRY - readings are for potential canopy cover	1	mature tree	small trees	mature trees	shrub/ small trees	135
5-11	54	16	1	1	grass/shrub	trees	Shrub/ small trees	shrub/ small trees	75
5-13	44	53	1 (side channel was dry)	2	shrub	shrub	Shrub /small trees	shrub/ small trees	100
5-17	76	87	1	1	mature forest	mature forest	mature trees	mature trees	30
5-29	81	71	1	1	mature forest	mature forest	mature trees	mature trees	20

* Values from Aerial Photo Analysis
† 2-11: Large variability from 1996 photo
§ 2-29: Check aerial photo analysis?
∞ 3-25: Power line disturbance

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